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ABSTRACT

During the past several years topics related to technological literacy and technology education have received increasing attention by policymakers at all levels of government. This report documents the attainment of the initial objectives set forth in an earlier report of the Commission, which was issued in 1985. A major section of this document deals with the transition to technology education, answering questions about technology, technology education, goals for technology education, and teaching methods in technology education. A second major section addresses technology in education for New Jersey, noting the major emphasis on awareness of technology education at the elementary school level, and the secondary level approaches to exploring, studying, and applying technology. Also included in the report are the Commission's recommendations, which are directed toward the commission itself, professionals involved in technology education, the New Jersey Department of Education, business and industry, and higher education institutes. (TW)

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ED288734

Report of the COMMISSION on TECHNOLOGY EDUCATION *for the State of New Jersey*

TECHNOLOGY EDUCATION: LEARNING HOW TO LEARN IN A TECHNOLOGICAL WORLD

1987

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This project was conducted pursuant to a contract from the New Jersey State Department of Education, Division of Vocational Education and was funded under P.L. 98-524. The contractors undertaking this project were encouraged to express their judgment in professional and technical matters. Points of view or opinions do not, therefore, necessarily represent official funding agency positions or policies.

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INTRODUCTION

This is the second report presented by the Commission on Technology Education for the State of New Jersey [formerly the Commission on Industrial Arts Education for the State of New Jersey]. The first publication, *Industrial Arts in Transition: the Emergence of Technology Education,* was issued in 1985. This initial document provided a three year plan of action for the industrial arts profession to begin development of a new body of knowledge termed "technology education". The first report was the result of the Commission's review of several documents including national assessments of the educational delivery system, technology implementation plans from various states, recommendations of the International Technology Education Association, and the *Report of the Governor's Commission on Science and Technology.*

During the past several years topics related to technological literacy and technology education have received increasing attention by policy makers at all levels of government. The critical role of the schools in preparing a society to meet the demands of an increasingly technological world has become an accepted priority. *In Educating Americans for the 21st Century,* the National Science Board Commission on Precollege Education in Mathematics, Science and Technology stressed the importance of technology education directed toward the needs of our future citizens:

> Students must be prepared to understand technological innovation, the productivity of technology, the impact of the products of technology on the quality of life, and the need for critical evaluation of societal matters involving the consequences of technology.

Ernest Boyer, in the Carnegie Foundation for the Advancement of Teaching Report entitled *High School: A Report on Secondary Education in America* cited the need for the study of technology that would lead to a more technologically literate citizenry:

> We recommend that all students study technology: the history of man's use of tools, how science and technology have been joined, and the ethical and social issues technology has raised.

In New Jersey, the Commission on Science and Technology specifically recommends "strengthened public school curricula to better prepare students for the challenges of our rapidly changing society." At the national level, legislation has been introduced in both houses of Congress to promote teaching of technology as part of the regular school curriculum. It was because of these challenges that the Commission on Technology Education for the State of New Jersey was organized in 1985. The activities of the Commission and the industrial arts profession have formulated the means to incorporate technology education into the public school curriculum.

The current report of the Commission documents the attainment of initial objectives as set forth in the original Blueprint for Action. It is this "blueprint" which is providing the structure to implement the "transition" toward technology education.

PSE&G Public Service Electric and Gas Company

80 Park Plaza, Newark, NJ 07101 / 201 430-5620 MAILING ADDRESS / P.O. Box 570, Newark, NJ 07101

E. James Ferland Chairman of the Board, President and Chief Executive Officer

May 14, 1987

Mr. George L. Fricke, Chairman
Commission on Technology Education in New Jersey
6000 Hadley Road
South Plainfield, New Jersey 07080

Dear Mr. Fricke:

It is clear that we are in the midst of a technology explosion that will continue into the 21st century. It is altering our lifestyle and, of course, our work style. We see it here at PSE&G where the methods of producing and delivering energy have changed immensely in recent years.

The future of New Jersey and the nation depends upon the ability of people to innovate, develop, and apply new technologies. To assure that this innovation process continues, it is of paramount importance that the education and training programs offered to our young people also move forward from the industrial arts training of the past into broad based technology education programs of the future. In this report, the Commission provides direction to fuel this transition, and offers a challenge to the State Department of Education, teachers, administrators, school boards, and the industries which will employ the graduates of these training programs.

New Jersey is a leader in the development and introduction of technology and is positioned to continue this leadership into the next century. The State is a pioneer in studying problems of national concern such as waste disposal, water supply, communications, transportation and energy. New Jersey's scientists, engineers, and technologists need to use all of their innovative talents to conquer today's problems and those of the future. The recommendations in this report provide the strong educational base needed to give today's students the opportunity to obtain the quality education needed to live and work in a dynamic technical world.

I strongly endorse this report and the Commission's work. I urge that the recommendations be implemented quickly to provide New Jersey's students with the tools to productively participate in an exciting future.

Sincerely,

E James Ferland

CHAIRPERSON'S SUMMARY

As I look back over the past two years and review the accomplishments of the Commission on Technology Education for the State of New Jersey and the industrial arts profession, I feel a real sense of pride. We've come a long way since the idea of technology education's evolution from industrial arts was first conceived. The importance of providing a curriculum that focuses on technology is evident by the addition of two new constituencies to the Commission: the New Jersey Commission on Science and Technology, and Public Service Electric and Gas Company.

This report documents the Commission's activities and accomplishments. A three year plan was developed, published and extensively publicized to begin this transition. We have realized the attainment of our objectives up to this date: developed a curriculum for the first level of a four-level articulated technology education curriculum; conducted assessment of several industrial arts programs using the Standards for Industrial Arts in New Jersey; submitted written and verbal testimony before the Panel on High School Graduation Requirements to request the inclusion of one year of technology education as a requirement for high school graduation; and formulated plans to accomplish the remaining tasks as identified by the 1985 Blueprint for Action.

In only two years of planning, curriculum development, and teacher training the benefits of a technology education curriculum have begun to produce remarkable results. New Jersey has received nationwide and international recognition for its unique approach to technology education. School administrators have seen increased motivation by teachers and pupils. The methodology of problem solving (the primary means for delivering technology education) has proven to be an effective technique for teaching critical thinking skills and bringing forth the creative talents of students through the application of knowledge gained by them in other disciplines. Technology education has proven to be a means for integrating many content areas into an activity-oriented, highly motivating, and extremely relevant curriculum.

The results were not accomplished by the Commission alone; education professionals have made significant contributions to our efforts. Contributions occurred through participation at a two-day workshop where teachers developed the initial concepts for the proposed technology education curriculum; a series of classes for inservice training of teachers; and the ongoing developmental and pilot testing of Technology Learning Modules for Levels I and II of the technology education curriculum. Moreover, in recognizing the need to maintain an identity which more accurately reflects the importance of technology in our ever-changing society, two of New Jersey's professional educational organizations—the Industrial Arts Education Association of New Jersey and the Industrial Arts Teacher Educators' Council—have changed their names. They are now known, respectively, as the Technology Education Association of New Jersey and the Technology Educators' Council.

What has been achieved so far is impressive, but we have a long way to go. The Commission has established some tough goals for the coming years. One major objective is to complete the materials for Level II of the technology education curriculum and begin development of Levels III and IV. Another goal is to promote the Technology for Children Project as the most viable means of incorporating technology education at the elementary school level. This curriculum will not require a great infusion of capital to be successful. Indeed, some of the recognized benefits of the technology education curriculum are: a prepared curriculum, and existing delivery system, at minimal investment cost.

Future challenges facing the Commission and technology teachers include development of a new plan of action to continue and expand the activities as identified in the original Blueprint for Action; integrating technology education with other disciplines; encouraging high school students to enter the field of teaching technology; increasing the number of schools offering technology education; providing additional inservice

training for teachers; and continuing the effort to require an approved technology education course as a requirement for high school graduation. These challenges will require the continued cooperative effort of educators and business/industry leaders. The goals of technology education are important for the young people in our state in order for them to make a greater contribution to New Jersey's future economy and to enjoy the fruits of technological achievements. In addition, the goals and strategies of the proposed technology education curriculum directly contribute to the fulfillment of Governor Thomas Kean's proclamation that New Jersey is the "Invention State".

I would like to thank the members of the Commission on Technology Education for the State of New Jersey and the industrial arts profession for their dedication and commitment. I know full well that the enthusiasm and creative energy exuded by the members of the Commission has not diminished over these past two years. For this reason I am confident of the successful attainment of the objectives as originally formulated by the profession. At the outset of this endeavor I felt it was important to incorporate technology education into the curriculum of our schools for the future of our state and its citizens, particularly its youth. I still feel this way—only more so.

George L. Fricke, Chairperson
Commission on Technology Education
for the State of New Jersey

RECOMMENDATIONS OF THE COMMISSION

The transition to technology education has presented many rewards, but the challenges of the future must be met if technology education is to become a reality. By identifying concerns and issues, the Commission is attempting to challenge not only itself, but all levels of human resource development within New Jersey: educators at all levels; school administrators; parents; and leaders in government, industry and business. These recommendations present realistic goals to be achieved and will foster New Jersey's leadership role in educating its populace to meet the technological challenges of the 21st century.

1. **Recommendation for the Commission on Technology Education:**

   Develop a new Blueprint for Action to continue and expand the activities as identified in the original plan of the Commission. The new plan will provide direction for the Commission and the profession in continuing the transition to technology education.

2. **Recommendation for the Commission and professionals involved in technology education:**

   Encourage high school students to enter the field of technology teaching. In the next few years a drastic shortage of teachers will occur. Colleges preparing students to enter technology education are graduating an inadequate number of students to fill these vacancies. A concerted effort must be made to attract young people into this exciting and challenging field of education. Establish a scholarship program to entice high school pupils to enter technology teaching as a career.

3. **Recommendation for the Commission, professionals involved in technology education and the New Jersey Department of Education:**

   Increase the number of schools offering technology education programs. This must be accomplished through additional teacher training, public awareness and the willingness of school administrators and teachers to accept the challenges of instituting new curricular offerings. Continued effort must be made to further develop the curriculum packages across all levels of the technology education curriculum. Developing and pilot testing new Technology Learning Modules must be a continual process because technology is a constantly developing phenomenon. The development of technology education activities must be as dynamic and challenging as technology itself. The New Jersey Mini Inventions Innovation Team is a good example of a continually developing curriculum activity.

   Continue efforts by the Technology Education Association of New Jersey and the Technology Teacher Education Council of New Jersey to provide inservice technology education programs for teachers wishing to modify and expand their existing curriculum.

4. **Recommendation for the New Jersey Department of Education and professionals involved in technology education:**

   Promote the Technology for Children project through inservice training and integrate its strategies with the total school delivery system. Technology for Children Project is the most appropriate approach currently available in New Jersey for the delivery of technology education at the elementary school level.

5. **Recommendations for the Commission, and business and industry:**

   Continue and improve the dialogue between those elements of society whose primary responsibility is education and the business/industry sectors. It is through this active liaison that an effective, dynamic and influential structure to promote technology education can be continued and expanded.

   Continue the effort to require an approved technology education course of study as a requirement for high school graduation. An alternate but less desirable proposal is to allow each school district the option of offering an approved technology education course which meets the second year science requirement.

6. Recommendation for the New Jersey Department of Education and Department of Higher Education:

Establish within the Department of Education a state supervisor[s] for technology education. In addition, technology education undergraduate and graduate programs should be established leading to teaching certification as "Teacher of Technology Education" for grades K - 12.

7. Recommendation for the Commission:

Increase membership of the Commission to include fields of science, English, business, social studies, humanities, art and mathematics. Technology by its very nature is multi-disciplinary. Technology education is not the sole domain of one discipline. It is when these disciplines, along with teachers trained in technology education, form a cohesive and cooperative educational unit that the full potential of technology education will be realized.

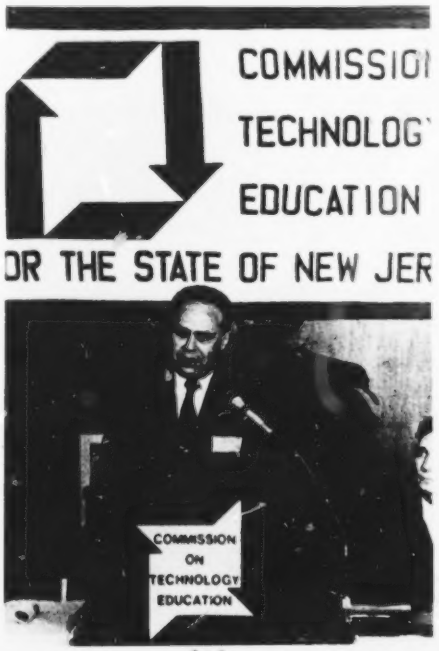
8. Recommendation for the New Jersey Department of Higher Education, business and industry, and professionals involved in technology education:

Encourage the establishment of courses at the undergraduate level which will provide the benefits of a technology education curriculum to college students. Undergraduate students should be familiar with the impacts of technology and should have the knowledge to make critical judgments regarding technology. Students at this level will have an immediate impact on technologies as they begin the process of career preparation. The 1985 Commission report stated that, "by developing an interest in problem solving techniques, technology education will open up a world of career possibilities for these students and foster the confidence needed for active participation in adult life".

The attainment of these recommendations will enable technology education to provide instruction in the process of "learning how to learn" in a technological world. This learning involves the application of physical laws; mathematical skills; and experiences with materials, processes and systems of technology explored within the context of creative problem-solving and critical thinking. The primary goal of technology education is an experience which teaches students "how to think," not "what to think". Such a program challenges the traditional boundaries between disciplines and, in doing so, attempts to more accurately reflect the role of technology in today's society.

"[We need to] get technology education universally on line so every student has an opportunity to become technologically literate. It seems to me that if we started to make technology education a requirement of high school graduation, it would go a long way toward that goal."

—Anton J. Campanella
President, New Jersey Bell
May 14, 1987



THE TRANSITION TO TECHNOLOGY EDUCATION

WHAT IS "TECHNOLOGY"?

Technology education is both a new curriculum and a strategy for teaching. Whereas industrial arts purported to take its subject matter from industry, technology education draws its content from the more pervasive influence of technology. In order to understand technology education, it is important to understand what is meant by the concept "technology."

A dictionary yields a definition very close to "the application of the industrial arts" which may justify maintaining existing programs to some teachers. (In this case, the "industrial arts" means the processes of industry and not the educational curriculum associated with traditional industrial arts programs.) But this concept is not consistent with known facts about technology. It is clear, for example, that weather forecasting is a technological activity, but it does not fit well into such a definition. Industry uses technology, but technology also exists outside of industry. It is not usually thought that the development and application of synthetic joints for the human body fall under the category of "industry". But, the design and development of these components and their installation into the living body are examples of some of the most advanced technological practices in the world today.

There is a misconception that technology is a "thing," e.g. an artifact. The idea that a computer is technology, for example, is not uncommon. However, the computer itself is the RESULT of technology, that is, a device which owes its existence to the process of technology.

Although technology is difficult to define, a definition which addresses technology as a process has been gaining acceptance because it is readily understood by both educators and students:

> Technology is the application of knowledge to satisfy human needs and wants, and to extend human capabilities. First, this definition implies that technology concerns needs and wants of humans, including both shelter and perfume, food production and spacecraft, protection against harsh environments and VCRs. Second, technology addresses the extension of human capabilities (the telescope or microscope to extend sight, the computer to extend the brain, and satellite communications to extend our listening range, among many other examples).

This definition also implies much by what it does not say. It does not say that technology is solely the application of science. In fact, technology has made some of science possible. The technology of brewing and winemaking led to the study of organic chemistry; the technology of the telescope led to the science of astronomy and a new concept of the organization of the universe. In these instances, before people understood why certain events occurred they knew the techniques for making them happen. Simply stated, science attempts to describe the physical world and discover new knowledge, whereas, technology attempts to modify the physical world. The study of technology can provide a rational basis for the study of science. Both of these disciplines are mutually reinforcing and can provide the foundation for curriculum innovation and creativity.

Technology, according to this contemporary definition, is a process that brings together human and material resources to solve problems. To study technology, therefore, is to analyze available resources, how these resources can be interrelated, and what can be expected as a result. This is all accomplished by designing—a process which has as its goal the solution of technological problems—commonly called "problem solving". Students employing this process utilize the same processes used in industry and other technological endeavors to produce products, develop and maintain systems, pioneer new techniques , and perform complex tasks.

WHAT IS "TECHNOLOGY EDUCATION"?

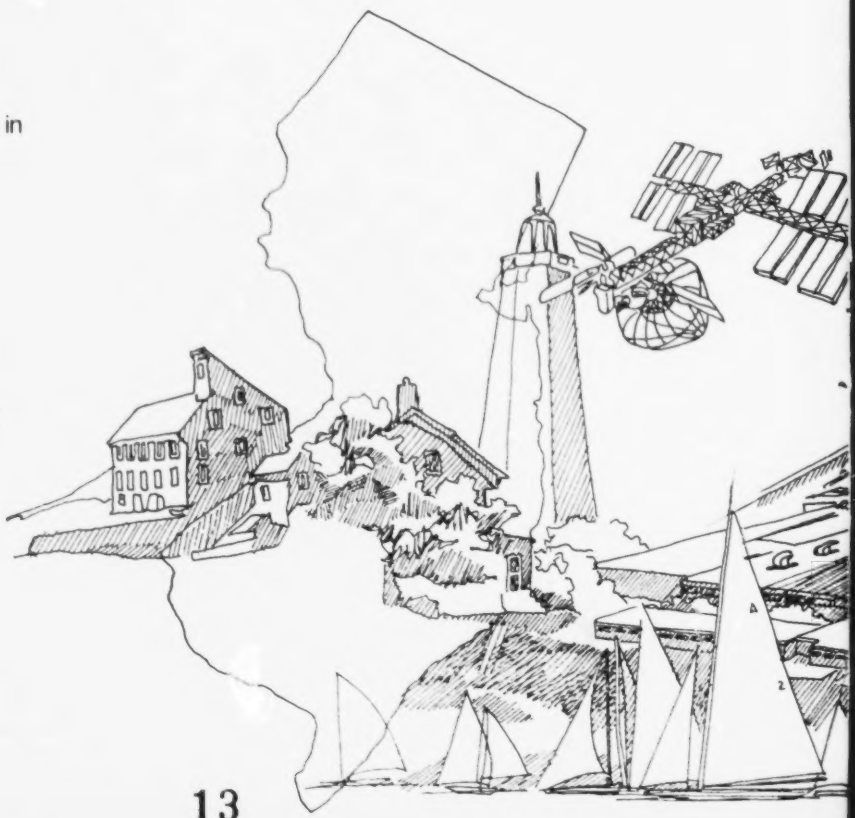
In a paper presented at the 1987 National Science, Technology, Society Conference on Technological Literacy, James Barnes (President, International Institute for the Study of Technology) reported on the results of a study which identified "the key descriptors of a definition of technology and the appropriate curricular organizers for the study of technology." A three round Delphi technique was used to conduct the research for the study. Seven panels, composed of five members each, included: (1) technology education professionals, (2) industrialists/business leaders, (3) futurists, (4) historians of technology, (5) anthropologists of technology, (6) philosophers of technology, and (7) philosophers of education. The key descriptors for the study of technology were determined to be:

- Innovation
- Invention
- Creativity
- Extension of human capabilities (physical, social, intellectual)
- A process (change, individual, corporate, design, creative and systematic)
- Extension of human potential
- Problem solving
- Purposeful, human manipulation of the material world
- Closely linked to science but not simply the application of science
- Body of knowledge
- Use of problem solving and creation of opportunities
- How technology played an important role in the emergence of Homo Sapiens
- A system of tools, knowledge and behaviors associated with the exploitation of environments
- Has social, economic, political and environmental impacts
- Application of knowledge
- Mutual influence between technological society
- Technological innovation (the appearance and uptake of new technologies)

Dr. Ronald Todd of New York University provides a concise definition of the study of technology which articulates the descriptors as identified in the Barnes study. Technology education is:

> the study of the nature of adaptive systems to include their basic elements (tools, materials, processes, energy, information and humans); the growth of those systems; the use of knowledge and technical means in solving practical problems; and the impacts of these elements, systems and activities on individuals, society and culture.

This definition of technology education differs slightly from the original definition published by the Commission in 1985. Although consistent with the original definition, the above definition provides a broader perspective in the study of technology. Technology education emphasizes career awareness, consumer knowledge, impacts and consequences of technology, creative problem solving techniques, understanding of technical systems; application of science, mathematics, language arts and computers; activity oriented experiences in technology; and an interdisciplinary approach to education. Thus, the educational field that concerns itself with the study of technology as a uniquely human endeavor is termed "technology education."



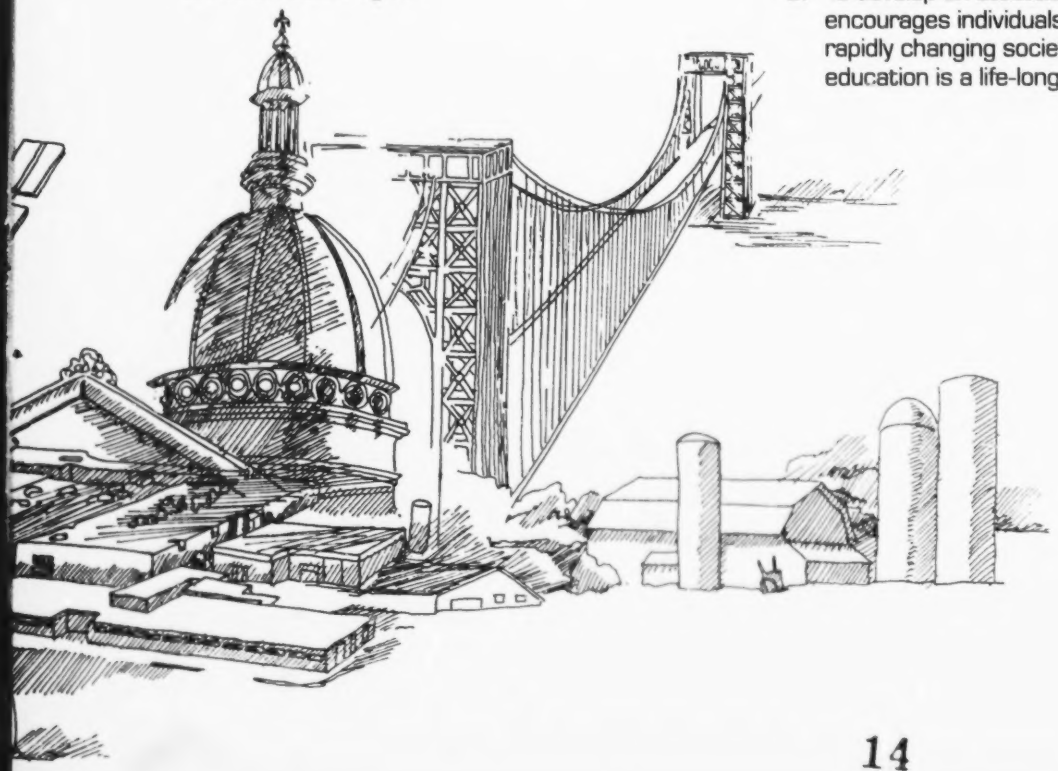
WHAT ARE THE GOALS FOR TECHNOLOGY EDUCATION?

The Delphi study conducted by Barnes also identified the curricular "organizers" which form the content for the study of technology. These curricular organizers have been identified as:

- Problem solving
- Process organizers
  - Creativity
  - Enterprise
  - Systems
  - Inventions
  - Problem Solving
- Values in technology
- The process of technology
- Design and innovation
- Research and development
- Awareness of implications and potential of technology
  - Health
  - Food
  - Communications
  - Production
  - Control
- Philosophy of technology
- Capability
  - Investigating
  - Inventing
  - Implementing
  - Evaluating
- Limits of technologies

In the Fall of 1986 the Commission, with input from several constituencies, adopted the following objectives for technology education which are consistent with the curriculum organizers in the Barnes study:

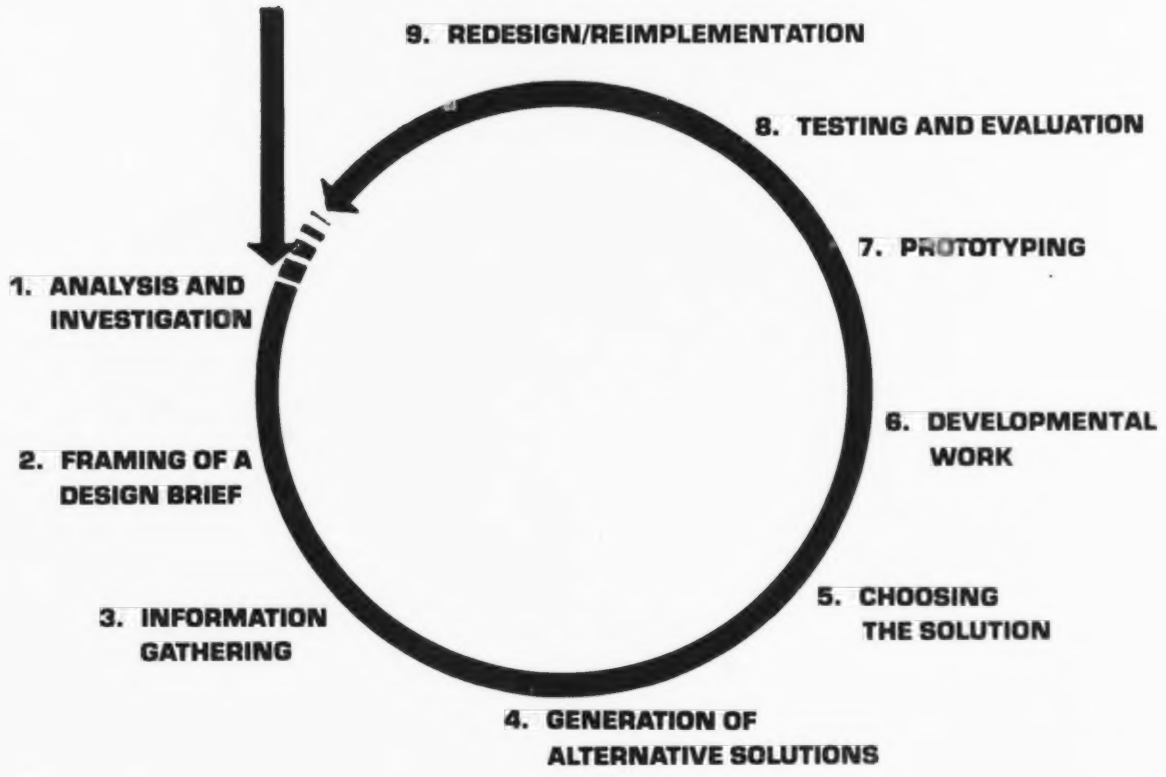
1. To help all students make informed career choices.
2. To help all students make informed decisions as consumers of technology in all aspects of their lives.
3. To develop within students an understanding of the impacts and consequences of technology so that as citizens they can exercise control over these developments as well as recognize the need and desirability of technological developments.
4. To have students apply creative problem solving techniques to the solution of technical problems.
5. To develop within students an understanding of resources, processes and outputs and their interrelationships within technological system.
6. To have students apply the concepts of mathematics, science, social studies, language arts, humanities, and the arts in the context of contemporary technology.
7. To engage students from all sectors of society in meaningful, first hand experiences in technology.
8. To use technology as a catalyst for an interdisciplinary approach to education.
9. To develop an attitude within students that encourages individuals to keep pace with a rapidly changing society and realize that education is a life-long process.



WHAT IS THE METHOD OF TEACHING USED IN TECHNOLOGY EDUCATION?

If technology education is to impart more than simple facts and if the understanding of the process of technology is an important objective of the program, then technology education should place the student in a position to participate as a decision maker in the technology process. Technology education allows students to play a variety of roles such as designer, engineer, fabricator, controller, evaluator, and consumer. As confidence and skill develop within students through designed experiences, less and less direction is given to students and the teacher assumes a "facilitator" role. In this manner students must take on more and more responsibility to think for themselves. Through application of the problem solving model, teachers will require students to determine answers themselves rather than relying on teachers to give solution to problems.

The "Design Loop" provides an educational model which emphasizes the continuing and holistic nature of the technological design process, as illustrated below.



The technological design/problem solving process includes:

1. **ANALYSIS AND INVESTIGATION OF A REAL-WORLD SITUATION**—The process should logically start with a critical examination of a real-world situation to determine the presence and nature of a problem.

2. **FRAMING OF A DESIGN BRIEF**—A statement describing what a solution to the problem should do and what constraints are being imposed is necessary to keep the process on track.

3. **INFORMATION GATHERING**—Before attempting to develop solutions, the designer [student] must become familiar with the influencing factors associated with the problem. What attempts have others made to solve this problem? What are the sizes, stresses, loads, power requirements, appearance and ergonomic factors involved? These are some of the sub-problems which must be addressed if viable solutions are to be found.

4. **GENERATION OF ALTERNATIVE SOLUTIONS**—If this were a mathematical or scientific problem only one answer would probably be correct. But in a technological problem there are no right or wrong answers, only good and bad solutions. To arrive at a good solution the designer will need to look at many alternatives. Students will probably find this the most challenging step in the process, calling for originality and flexibility.

5. **CHOOSING THE SOLUTION**—From the alternative solutions developed, the student must choose one which best satisfies the demands of the situation and the design brief. He/she should be able to defend the choice with reference to each requirement of the situation and brief.

6. **DEVELOPMENTAL WORK**—[drawings, evolutionary models, simulations, etc.] This step may manifest itself in the form of a device, computer simulation, a series of graphic sketches or a 2-dimensional model made of flexible materials. The design brief and initial problem/need will specify the final outcome of this step. Often the student will make various models before making an operational device. Appearance is not very important at this stage. Appearance takes on importance after testing and evaluation have confirmed that the solution chosen meets the specified requirements. Developmental work also includes technical planning of procedures and resource management

7. **PROTOTYPING**—This is the actual construction/realization step of the process. Appearance is more important here, but only so far as the need to "sell" the idea or product. After the device is tested and revised, the prototype may be "finished" for final demonstration. The device or product should be operational and quality work should be in evidence.

8. **TESTING AND EVALUATION**—The solution should always be evaluated against the requirements established in the design brief, and against the original problem statement. Testing the solution to see if it handles the load, operates correctly, meets appearance requirements, is reliable and solves the problem is an important part of the design process. Evaluating the result should address the need for improvements, changes, etc.

9. **REDESIGN/REIMPLEMENTATION**—If there is time, the evaluated and tested solution may be re-worked and re-tested. This is especially important if the product is to be produced in any quantity or if it is to be put into actual use to solve a real-life problem. At this stage, the appearance of the product takes on more importance.

   Even if the product isn't taken to real-world application—consideration should be given to how the solution would [or does] "change the world". Such consideration "closes the loop," reinforcing the nature of design as suggested by the model, and provides a forum for considering the idea of "impacts".

As technological advances occur in the world, a common element is needed by citizens: the ability to solve problems arising from change. Technology education teaches students the concepts of problem solving while engaging them in the designing/making process.

TECHNOLOGY EDUCATION FOR NEW JERSEY

Technology in the curriculum (kindergarten through grade 12) is organized into five levels incorporating four concept phases. Each of the levels provides a unique contribution to the understanding and application of technology in the world. In addition, each level and corresponding concept phase has appropriate applications in the related developmental and educational experiences of students.

ELEMENTARY LEVEL: DEVELOPING AN AWARENESS OF TECHNOLOGY

At the elementary school level, emphasis is placed on developing an understanding of the pervasive nature of technology and its history/evolution. The integration of technology concepts with other school subjects is stressed through visual, graphic and verbal communications. At this level, the systems and processes of technology, including limited applications through activity-based experiences, are infused into regular classroom work. A thematic approach, one which organizes study in a number of school subjects around a common theme, provides the focus for developing an awareness of technology. "Technology for Children" (T4C) is a curriculum designed to meet the goals of technology education at the elementary level. T4C is offered at the earliest possible grade levels, when children are naturally curious about the world around them.

The New Jersey T4C Program fosters the development of technological literacy. By participating in T4C, students in kindergarten through sixth grades are provided individualized, experimental learning opportunities that integrate the total elementary school curriculum. A broad range of technology -oriented experiences are introduced through themes such as aerospace, communications, computer applications, consumerism, energy, entrepreneurship, environmental studies, health (including nutrition) and invention/innovation.

Each experience requires practical applications of learning which help students become aware of the relationship between their school subjects and the technological world in which they live. The major objectives of T4C are to assist students to:

1. Develop skills, confidence and competence in using technological tools, materials and processes to complete assignments.
2. Develop and apply problem solving/critical thinking skills.
3. Identify careers associated with various technology experiences.
4. Develop awareness of their individual abilities, needs and interests.
5. Apply basic literacy skills to solve technological problems.
6. Develop an awareness of future trends that will affect their lives.
7. Develop an understanding of the relationship between school and the world in which they live.
8. Interact with technology, free of bias.

Through T4C experiences students will become more self-directed, life-long learners capable of applying these transferable skills throughout their lives.

LEVEL I: EXPLORING TECHNOLOGY

As children begin to specialize in courses devoted to separate disciplines (usually during the middle school years), the importance of technology in shaping their future should be emphasized as an important part of that education. Almost every choice of career a child makes is shaped by technology. The middle/junior high school years are especially influential in the career development process. Exploring technology (Level I) in at least one full-year course (or equivalent) between grades 7 and 9 provides children with the broad exposure needed to put technology in perspective with their lives.

The course "Introduction to Technology" is used at this level and emphasizes the evolution of technology, design/problem solving processes and the systems approach to understanding technology. The areas of informational, physical and biological technologies are explored through the application of design/problem solving activities which engage students in first-hand, activity-oriented experiences with technology. The course acquaints students with the impacts of technology on the individual and society, as well as related technological career options. The thematic approach is an integral component of the exploration of technology. "Introduction to Technology" consists of the following six modules (units of instruction):

MODULE I: INTRODUCTION TO TECHNOLOGY

The first module has the same title as that of the course. It is intended to acquaint the student with technology through very broad experiences. Technology is introduced by exciting and meaningful activities which capture the imagination and interest of students. Activities in this module are short and involve minimal skill development. This module attempts to capture the enthusiasm and interest of students rather than develop any degree of technical proficiency.

MODULE 2: DESIGN/PROBLEM SOLVING IN TECHNOLOGY

The design/problem solving module focuses on the basic concepts, cognitive skills and process of solving technical problems. Emphasis is placed on the students learning the process of problem solving and not the artifact produced as a result of the process. Most activities in this module are fairly prescribed and allow the student to move through the design process steps. The following modules utilize the problem solving skills developed in module two.

MODULE 3: HISTORY/EVOLUTION OF TECHNOLOGY

The history/evolution module is intended to provide the student with a perspective view of how technology has evolved; the impact of technology on the development of early artifacts as well as possible future directions; and the influence of technology on humans, their culture, values and quality of life. Activities in this module may involve the design and fabrication of devices using period tools and technology, the construction of operational models of period tools and machines and/or activities centered around a futuristic theme.

MODULE 4: SYSTEMS OF TECHNOLOGY

The systems module is intended as an introduction to the systems model of technology. The systems model is a mechanism for understanding technology by analyzing inputs, resources, processes and outputs. Processed by technological systems, information, energy and materials are altered. Activities in this module may involve the development and construction of simple systems as well as the analysis of technological systems in the world.

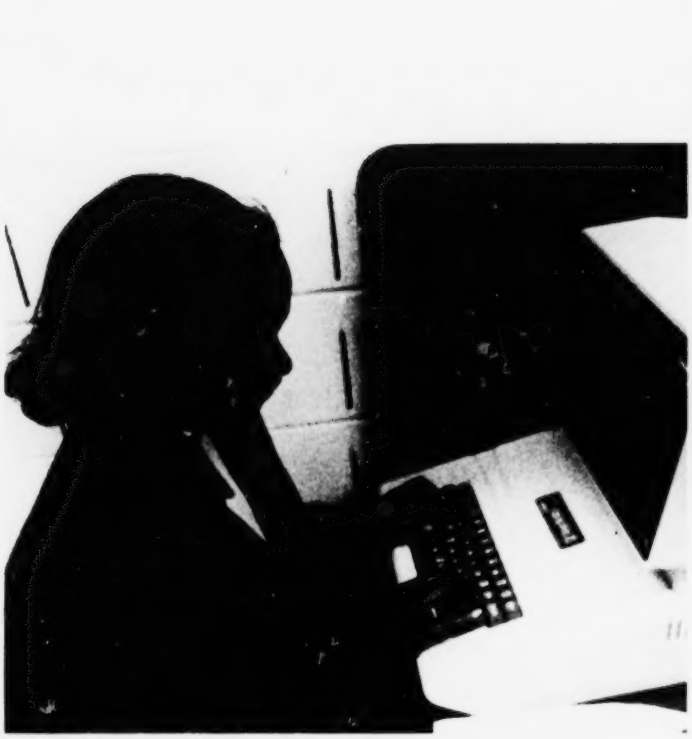
MODULE 5: RESOURCES OF TECHNOLOGY

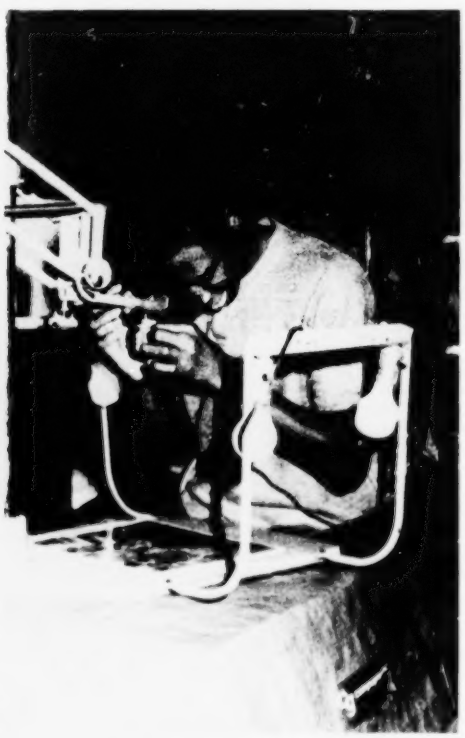
The resources module is intended to acquaint the student with the resources of energy, information, materials, tools/machines, capital and humans which are necessary for technology to take place. These resources are the inputs to the processes employed in any technological development. Activities in this module include

first hand experiences with one or more of these resources to provide the student with insight into the difficulty of resource choice and its effect on the system process and outputs. The students learn to appreciate questions related to "possible", "feasible" and "desirable" resources.

MODULE 6: CONTROL TECHNOLOGY

The control technology module is intended to acquaint the student with the basic "building blocks" of modern technology. Emphasis is placed on understanding simple mechanisms, and mechanical and electronic control. Activities include simple problem solving in the design and fabrication of model mechanical devices using gears, cams, levers, electrical, pneumatic and hydraulic control of mechanical devices.





LEVEL II: STUDYING TECHNOLOGY

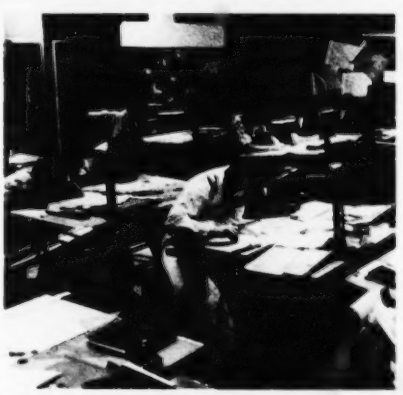
An exploratory experience in technology is not sufficient to develop the qualities needed by citizens to cope and function effectively in the complex world of tomorrow. An informed and technologically competent citizenry is crucial to the success of the democratic process in a technologically oriented society. Further study of technology (Level II) to develop these qualities is needed by all students during the secondary school years. In this phase, students are permitted to choose from a number of courses. With the broad background developed during the awareness and exploratory phases, students may now follow his/her own interests through rich and relevant experiences in technology. Emphasis at this stage is on direct involvement with technology and analyzing technology's consequences to the individual and society.

Through the design/problem-solving process, and the application of basic skills related to math, science and written/verbal communications, students study the processes and elements of technology. By inventing and solving "real world" problems students gain a broader perspective of technology in society. The impacts on humans and the environment, relative to specific technological areas, are studied. These activity-oriented experiences build upon the knowledge gained in Level I. The courses "Invention and Innovation" and "Enterprise" are currently in the developmental stage. Additional courses to complete Level II are in the concept and planning phase.

LEVELS III & IV: APPLYING TECHNOLOGY

The final phase (Levels III & IV) of the technology education curriculum model applies technology to specific instances. Experiences at this level are organized into general, vocational/technical and pre-engineering. Students have the opportunity to gain in-depth experiences and expertise according to their career paths in courses tailored to their needs and interests. By applying more complex processes to the solution of technical problems, students develop and utilize critical thinking skills and sophisticated concepts related to math, science and other disciplines. Group and individual activities in design and realization permit students to gain a greater understanding of a specific technology area and the career opportunities it offers. Courses designed to fulfill the concepts of Levels III & IV are in the discussion phase.

As can be seen, the New Jersey Technology Education Model is designed to serve all students at all grade levels.

CONCEPT PHASE	LEVEL	GRADE	
DEVELOPING AN AWARENESS OF TECHNOLOGY	Elementary	K—6	
EXPLORING TECHNOLOGY	I	7—10	
STUDYING TECHNOLOGY	II	9—12	
APPLYING TECHNOLOGY	III & IV	10—12	

* This is not an exhaustive listing of potential courses. This list is intended to serve as examples of possible course offerings in the Technology Education Model.

TECHNOLOGY EDUCATION MODEL

GOALS	COURSES*
• Develop an awareness of technology as a significant force in their lives • Begin to develop life skills in problem solving • Develop the idea that technology is the application of knowledge to solve human problems and extend capabilities	• Technology for Children
• Develop consumer skills and literacy • Develop critical thinking and problem-solving skills • Provide exposure to a broad range of careers and occupations • Engage students in first-hand experiences with technology • Demonstrate how technology brings together knowledge and skills from all disciplines	• Introduction to Technology**
• Develop an understanding of technological issues facing citizens of New Jersey • Further develop and use critical thinking and problem solving skills • Apply math and science principles to the solution of problems • Develop an understanding of the impacts and consequences of technology on the individual and society • Help students make informed career decisions	• Invention & Innovation** • Enterprise** • Information Processing • Control Technology • Evolution & Consequences of Technology • Energy • Biotechnology • Technical Design & Presentation • Materials & Processes
• Develop in-depth knowledge and experience in technology • Gain experiences valuable to pursuits in further education • Help students make informed career decisions • Apply problem solving skills to the solution of community, industry and other real-life problems • Develop an attitude that learning is a lifelong process	• Research & Development • Production • Telecommunication • Construction Systems • Computer-Integrated Manufacturing • Robotics • Aviation/Aerospace • Electronic Communications • Transportation Systems • Graphic Communication

** Developed Courses

THE IMPACT OF TECHNOLOGY EDUCATION

The work of the Commission and the technology education profession over the past two years has resulted in several identifiable benefits to the profession and, more importantly, to students. The following is a synopsis of the impact of implementing a technology education curriculum as identified by teachers and administrators involved in technology education programs.

IMPACT ON STUDENTS:

1. Ability to use the problem-solving model and critical thinking skills.
2. Ability to use models to simulate real situations.
3. Ability to make real world decisions concerning the impacts and consequences of technology.
4. Ability to demonstrate how feedback is used to control social, political, economic, ecological, biological, and mechanical systems.
5. Ability to use the "tools" of technology to solve real world problems
6. Ability to recognize the relationship between mathematics, science, social studies, language arts and the humanities with technology.
7. Ability to question the possible effects of technological "improvements" on the society (environmental, political, economical, cultural, etc.)
8. Ability to weigh the merits and risks of new products and processes.
9. Ability to recognize that technology will create new possibilities for society.
10. Ability to trace and analyze the effects of technology on society from a historical perspective.
11. Ability to analyze the effect of technological advancements upon career choice and to realize that education is a life-long endeavor as a result of rapidly changing technology.

IMPACT ON THE STATE OF NEW JERSEY:

Recently, the New Jersey Commission on Science and Technology reaffirmed the importance of investing in the education and technical skills of the state's human resources. The Commission on Science and Technology identified several key areas for the structuring of human resource activities. Areas relating to technology education include:

1. Education and continuing education of elementary, secondary and college faculty for science and technology coursework.
2. Science and technology literacy for all New Jersey residents.
3. Elementary, secondary and undergraduate education, with a focus on the related sociological, curricular, and technological issues. Thus, the Commission on Technology Education is playing a key role in New Jersey's technology development strategy, by strengthening elementary and secondary technology education.

IMPACT ON THE PROFESSION:

1. Increase in the number of teachers taking inservice courses preparing them to teach technology education.
2. Increase the support and funding opportunities to develop and promote statewide and local technology education activities.
3. Increase in teacher motivation as evidenced by enthusiasm, attendance at technology education conferences and presentations, and experimentation with technology education within their classes.
4. Increase in the perceived value of technology education as a viable and relevant content area.
5. Increase in the visibility of technology education programs through recognition by external organizations, visitations to schools having technology programs by individuals interested in learning about technology education, and published articles about New Jersey technology education programs.
6. Increase in the number of schools desiring program assessment.
7. Interest by teachers from other disciplines wishing to participate in technology activities.
8. Increase in the contacts between the school and business/industry in promoting and participating in technology education activities.
9. Increase in pupil enrollment in technology education programs.

ACCOMPLISHMENTS OF THE COMMISSION

The 1985 report of the Commission, *Industrial Arts in Transition: the Emergence of Technology Education*, established a three year plan with specific objectives to be accomplished by the Commission in order to begin the transition to technology education. The following represents accomplishments of the Commission as of the Spring 1987.

RE-ESTABLISHED THE COMMISSION

The Commission on Technology Education for the State of New Jersey was reconstituted for the purpose of directing the industrial arts profession in achieving the goals as set forth in the Program of Work. The Commission membership was increased in order to meet the demanding workload and to incorporate constituencies which will support the implementation of technology education. The new members represent the New Jersey Department of Education (Division of Vocational Education), the New Jersey Commission on Science and Technology, and Public Service Electric and Gas Company. The Commission has met approximately every five weeks at the New Jersey Bell Corporate Training Center in South Plainfield, New Jersey.

CONDUCTED A TASK FORCE WORKSHOP

On October 17-18, 1985, thirty-four teachers and teacher educators were involved in a workshop at the Mohican Outdoor Resource Center in Blairstown, New Jersey. The purpose of the Task Force Workshop was to develop the philosophy, goals, and curriculum concept for technology education in New Jersey. The workshop was organized by Ronald Hanisch, Supervisor of Industrial Education, Monmouth Regional High School and Dr. Robert Nogueira, Principal, Red Bank Regional High School. The Task Force participants redefined the original Commission's goals for technology education in New Jersey.

DEVELOPED AND CONDUCTED PUBLIC INFORMATION CAMPAIGN

A public information campaign was organized for the purpose of developing strategies designed to inform the profession and the public of the plan for technology education in New Jersey. The following activities were undertaken by the Commission:

1. Approximately 200 copies of the 1985 report of the Commission were distributed by the Commission to teachers, administrators, members of the New Jersey Department of Education, leaders in business and industry, and administrators of the International Technology Education Association.

2. Approximately 700 copies of the 1985 report of the Commission were distributed throughout New Jersey by the Vocational Education Resource Center, Old Bridge, New Jersey.

3. The New Jersey Vocational Education Resource Center devoted its Trends Paper No. 18 to the Commission's report. The trends paper entitled "Intensive Technology Education Program Proposed for Grades 7 - 12" was distributed throughout New Jersey and the nation.

4. Kitta MacPhearson, science editor of the Star Ledger, published two editorials concerning the work of the Commission:
   "State Panel Urges Wider High-Tech Teaching", February 16, 1986.
   "Education Can Remove 'Magic' From Technology", February 17, 1986.

5. Presentations concerning the work of the Commission on Technology Education were made to the following organizations:

Industrial Arts Teacher Educator's Council of New Jersey, Blairstown, New Jersey (October 11, 1985)

New Jersey Education Association Convention, Atlantic City (November 7, 1985)

American Vocational Association Conference, Atlanta (December 8, 1985)

High School Graduation Requirements Panel, Paramus and New Brunswick, New Jersey (January 16, 1986)

Vocational Education Association of New Jersey Conference, Atlantic City (February 21, 1986)

Vocational/Industrial Arts Committee of New Jersey Education Association,Trenton (March 7, 1986)

International Technology Education Association Conference, Kansas City (March 25, 1986)

Monmouth County School Boards Association (September 11, 1986)

Industrial Arts Teacher Educator's Council of New Jersey, Blairstown, New Jersey (October 8-9, 1986)

New Jersey School Boards Association Conference, Atlantic City (October 16, 1986)

Industrial Arts Supervisor's Conference, Monroe, New Jersey (October 23, 1986)

Pennsylvania Industrial Arts Association, Harrisburg, Pennsylvania (November 6, 1986)

New Jersey Principals and Supervisors' Conference, Atlantic City (November 13, 1986)

Vocational Education Association of New Jersey Conference, Atlantic City (March 12, 1987)

Supervisors' Conference, Woodbridge, New Jersey (April 30, 1987)

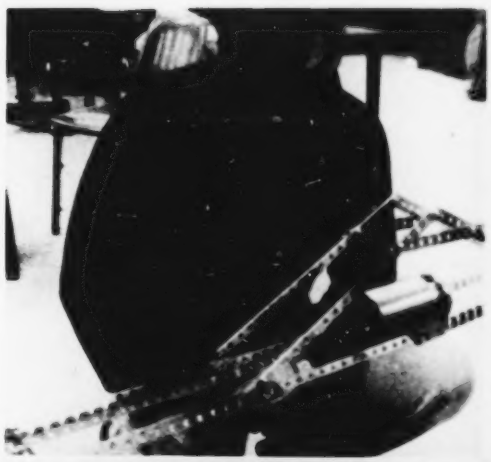
6. The Commission obtained representation on the Exhibit Review Committee of the New Jersey Science and Technology Museum.

7. A statewide Technology Education Conference was sponsored by the Commission and the Technology Education Association of New Jersey at the New Jersey Bell Training Center on May 14, 1987. The keynote speaker for the conference was Anton J. Campanella, President, New Jersey Bell.

8. On March 7, 1986, the plan for technology education as developed by the Commission and the industrial arts profession in New Jersey received the endorsement of the New Jersey Education Association through its Vocational Education Committee.

9. The work of the Commission and the technology education movement in New Jersey received international recognition with the Commission being invited to deliver a formal presentation at the "Technology, Education and Society: Future Directions" Centenary International Conference sponsored by the Royal Melbourne Institute of Technology, Melbourne, Australia (May 10-15, 1987)

10. Articles for publication have been developed concerning the technology education in New Jersey and have been submitted to the Journal of Epsilon Pi Tau, The Technology Teacher, School Leader (New Jersey School Boards Association), NJEA Review, and Workplace Education.



CONDUCTED INSERVICE WORKSHOPS

The Commission organized and conducted four graduate credit workshops during the past two years. The grant received from the New Jersey Division of Vocational education by the Commission permitted tuition costs to be waived for the participants. Approximately eighty individuals participated in these classes. The purpose of the classes was twofold: one, to introduce inservice teachers to the concepts and application of technology education; and two, to have the teachers develop additional Technology Learning Modules.

In addition, the Commission utilized the services of industrial arts teachers to field test Technology Learning Modules for the Level I curriculum and to develop Technology Learning Modules for the Level II curriculum.

PROVIDED TESTIMONY AT HIGH SCHOOL GRADUATION REQUIREMENTS HEARINGS

Members of the Commission have actively campaigned for the inclusion of technology education as a requirement for high school graduation. Position papers were developed and formal presentations were made at public hearings of the Panel on High School Graduation Requirements, placing emphasis on the critical need for a formal course in technology education for all New Jersey high school graduates. The Commission also endorsed a position paper developed by the Technology Teacher Educator's Council of New Jersey. The paper contained the recommendation of the Commission that each school district be given the option to substitute an approved course in technology for the second year science requirement.

ENCOURAGED PROGRAM ASSESSMENT

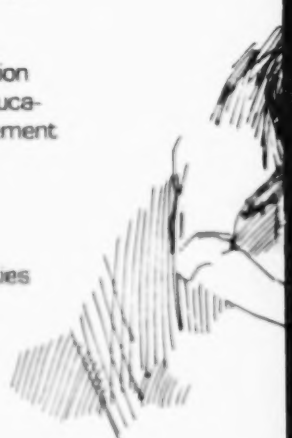
The Commission has endorsed the assessment of existing industrial arts programs using the Standards for Industrial Arts in New Jersey . The Standards are designed to promote program improvement through a systematic and standardized method. Approximately twelve school districts have been either assessed or are in the process of being assessed. This program review has resulted in a curriculum revision to reflect the goals of technology education, an improved image for the department, and an increase in teacher and pupil motivation.

In addition, the Commission has reviewed the Standards for Technology Education for adoption as the assessment instrument for technology programs in New Jersey. *The User's Manual: Standards for Industrial Arts in New Jersey* has been published which will assist schools in organizing and conducting an assessment of their programs.

The Division of Vocational Education of the New Jersey Department of Education has placed a high priority on program assessment. The Division of Vocational Education has made funds available to schools to conduct program review and to implement recommendations of the assessment.

DEVELOPED FUNDING PROPOSALS

Proposals seeking continued funding for the Commission and its related activities [as defined by the Blueprint for Action] have been submitted to the New Jersey Department of Education and the Division of Vocational Education.



PARTICIPANTS

The Commission wishes to acknowledge those teachers, administrators, schools and organizations which have participated in the activities of the Commission. The "Blueprint for Action" as identified in the 1985 report of the Commission could not have become reality without the active support and commitment of the industrial arts profession in the state, the Division of Vocational Education, the educational community, and the leadership of business and industry throughout New Jersey. The Commission recognizes the participation of the following organizations and schools in promoting technology education:

Absegami High School (Galloway Township)
Arthur Rann School (Galloway Township)
Audubon High School
Bernardsville High School
Bergenfield High School
Bridgewater-Raritan High School West
Brooklawn Junior High School (Parsippany)
Burlington High School
Butler High School
Camden City Middle Schools
Cape May County High School
Carteret High School
Central High School (Bayville)
Chatham Boro High School
Cherokee High School (Marlton)
Cherry Hill High School
Clifton Public Schools
Cranford High School
Cresskill Public Schools
Delanco Schools
East Brunswick High School (Brunswick)
Eastern Regional High School (Gibbsboro)
Edgewood Senior High School (Atco)
Eisenhower Middle School (Succasunna)
Englewood High School
Ewing High School (Trenton)
Fords Middle School

Fort Lee High School
Franklin High School (Somerset)
Freehold Regional High School
Garfield High School
Glassboro State College
Haddon Township High School
Heritage Middle School (Livingston)
Hopatcong Public Schools
Jackson Memorial High School
Jersey City Public Schools
John Adams Middle School (Edison)
Kean College of New Jersey
Kinnelon High School
Kittatinny Regional High School (Newton)
Lakeland Regional High School (Wanaque)
Lawrence Township Schools
Lounsberry Hollow Middle School (Vernon)
Lyndhurst High School
Manchester Township High School (Lakehurst)
Marlboro High School
Memorial School (Union Beach)
Monmouth Regional High School
Monongahela Junior High School
Montclair State College
New Jersey Bell
New Jersey Commission on Science and Technology
New Jersey Department of Education, Division of Vocational Education
New Jersey School Boards Association
New Jersey Vocational Education Resource Center
North Bergen High School
North Plainfield High School
Northern Burlington County Regional High School (Columbus)
Northern Highlands Regional High School (Allendale)
Ocean Township High School
Paramus High School
Pascack Valley High School (Hillsdale)
Palmyra High School
Pennsauken High School
Pequannock High School
Perth Amboy High School
Phillipsburg High School
Princeton Day School
Public Service Electric and Gas Company
P.S. 2 & 5 West New York
P.S. 24 Paterson
Red Bank Regional High School
River Dell Senior High School
Sayreville War Memorial High School (Parlin)
Shore Regional High School (West Long Branch)
Spotswood High School
Technology Education Association of New Jersey
Trenton Central High School
Trenton State College
Wallington High School
Wallkill Valley High School (Hamburg)
Washington Township School District (Pitman)
Wayne Public Schools
West Brook Middle School
West Windsor-Plainsboro High School
Whippany Park Middle School
William Satz School (Holmdel)
Woodbridge Township School District
Y.A.L.E. Middle School (Berlin)

PUBLICATIONS OF THE COMMISSION

Industrial Arts in Transition: the Emergence of Technology Education, 1985.

The Teacher's Guide to Technology Education, 1987.

Level I: Introduction to Technology Education, 1987.

All publications are available from the Vocational Education Resource Center, Aberdeen, New Jersey.

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